

IN THE CLAIMS:

The text of all pending claims, (including withdrawn claims) is set forth below. Cancelled and not entered claims are indicated with claim number and status only. The claims as listed below show added text with underlining and deleted text with ~~strikethrough~~. The status of each claim is indicated with one of (original), (currently amended), (cancelled), (withdrawn), (new), (previously presented), or (not entered).

Please AMEND claims 1, 7, 13-15, 19, and 20 in accordance with the following:

1. (CURRENTLY AMENDED) A RAID apparatus comprising:

a plurality of physical disk units storing a plurality of copies of each of logical volumes; and

a disk controller accessing any of the physical disk units which stores a designated logical volume to thereby access said designated logical volume,

said disk controller including:

a memory storing the number of operations requested to each physical disk unit, for each physical disk unit, and

control means for accessing one of said plurality of physical disk units which stores the designated logical volume, in accordance with said number of operations,

wherein said control means compares numbers of operations corresponding to a plurality of physical disk units which store said designated logical volume with each other, selects the single physical disk unit from among the disk units storing the designated logical volume which has a minimum number of operations based on the comparison, and outputs a request to only the selected single minimum waiting physical disk unit having the minimum number of operations based on the comparison,

wherein said control means increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said physical disk units performs requested operations in a queued order,

wherein said memory stores a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volumes and status information indicating statuses of said physical disk units; and said control means, which

refers to said memory with said designated logical volume, judging whether or not said status information of logical volume indicates abnormal, ~~and~~ selects said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers, when a plurality of physical disk units storing copies of said designated logical volume are normal, with said status information of said logical volume, and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal, ~~and~~

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume, and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.

2. (CANCELED)

3. (PREVIOUSLY PRESENTED) The RAID apparatus according to claim 1, wherein said control means includes:

a channel adapter circuit performing interface control with said high-rank apparatus; a device adaptor circuit accessing said physical disk units in accordance with a requested operation; and

a resource manager circuit determining one of the plurality of physical disk units to be accessed in accordance with said number of operations in said memory in response to a transfer request from said channel adapter circuit, and requesting said device adapter circuit to perform an operation accessing said determined physical disk unit.

4. (CANCELED)

5. (CANCELED)

6. (CANCELED)

7. (CURRENTLY AMENDED) An access control method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, and a disk controller accessing any physical disk unit which stores a designated logical volume to thereby access said designated logical volume, said method comprising:

determining a plurality of physical disk units which store a designated logical volume; and

selecting from among the determined disk units storing the designated logical volume

one of said determined physical disk units in accordance with the number of operations requested to said physical disk units, said selecting comprising:

comparing said numbers of operations of a plurality of physical disk units which store said designated logical volumes with each other,

accessing the single physical disk unit which has a minimum number of operations based on the comparison and outputting a request to only said selected waiting physical disk unit having the minimum number of operations based on the comparison,

incrementing the number of operations of said accessed physical disk unit in accordance with a request for said operation, and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said plurality of physical disk units performs requested operations in a queued order, and

wherein said selecting further comprises referring to a memory storing a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volumes and status information indicating statuses of said physical disk units, judging whether or not said status information of logical volume indicates abnormal,

selecting said physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume, are normal from said status information of said logical volume and selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal, and

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume, and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.

8. (CANCELED)

9. (CANCELED)

10. (CANCELED)

11. (CANCELED)

12. (CANCELED)

13. (CURRENTLY AMENDED) A RAID apparatus comprising:

physical disk units storing redundant logical volumes, a first of the redundant logical volumes being stored on one of the physical disk units, and a second of the redundant logical volumes being stored on another of the physical disk units; and

a disk controller counting numbers of operations respectively requested of each of the physical disk units and accessing one of the first and the second of the redundant logical volumes based on a minimum number of the numbers of operation respectively requested of each of the physical disk units storing the redundant logical volumes based on the counting, and outputting a request to only the accessed single physical disk unit having the minimum number of operations based on the comparison,

wherein said disk controller increments the number of operations of an accessed physical disk unit in accordance with a request for said operation and decrements the number of operations of an accessed physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said physical disk units performs requested operations in a queued order,

wherein said disk controller refers to a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each said redundant logical volumes and status information indicating statuses of said physical disk units; judges whether or not said status information of logical volume indicates abnormal; selects said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of the logical volume, and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal, and

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume, and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.

14. (CURRENTLY AMENDED) A RAID controller accessing one of a plurality of

physical disk units storing a plurality of copies of each of logical volumes to thereby access a designated logical volume, comprising:

a memory storing a number of operations requested of each physical disk unit corresponding to each physical disk unit; and

a controller comparing said numbers of operations corresponding to a plurality of physical disk units which store a designated logical volume with each other, and selecting a single one of said plurality of physical disk units which has a minimum number of operations from among the plurality of physical disk units storing the designated logical volume based on the comparison and outputting a request to only said selected single physical disk unit having the minimum number of operations based on the comparison,

wherein said controller increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said plurality of physical disk units performs requested operations in a queued order,

wherein said memory stores a table indicating a plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volumes and status information indicating statuses of said physical disk units; and said designated logical volume of said physical disk units; judges whether or not said status information of logical volume indicates abnormal and said status information of logical volume indicates abnormal, selects said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of the logical volume, and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal,and

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume,and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.

15. (CURRENTLY AMENDED) A balancing access method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, comprising:

comparing numbers of operations of a plurality of physical disk units which store a

designated logical volume with each other;

selecting a single one of said physical disk units which has a minimum number of operations from the disk units storing the designated logical volume based on the comparison and outputting a request to only said selected single minimum waiting physical disk unit;

incrementing the number of operations of said accessed physical disk unit in accordance with a request on said operation; and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said physical disk units performs requested operations in a queued order,

wherein said selecting further comprises referring to a memory storing a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volumes and status information indicating statuses of said physical disk units; judging whether or not said status information of logical volume indicates abnormal, and selecting said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume, and selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said disk unit among said plurality of physical disk units when said status information of said logical volume indicates abnormal, and

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume, and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.

16. (CANCELED)

17. (PREVIOUSLY PRESENTED) The RAID apparatus according to claim 1, wherein said table in the memory comprising:

a logical volume structure table storing statuses and said plurality of physical disk units of each logical volume; and

a disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said control means refers to said logical volume structure table with said designated logical volume, and selects said single physical disk unit on which said designated

logical volume is allocated by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table and selects a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

18. (PREVIOUSLY PRESENTED) The access control method according to claim 7, wherein said referring comprises referring said memory comprising a logical volume structure table storing status of and said plurality of physical disk units of each logical volume and disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said selecting comprising: selecting said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table; and selecting a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

19. (CURRENTLY AMENDED) A RAID apparatus comprising:

a plurality of physical disk units storing a plurality of copies of each of logical volumes;
and

a disk controller accessing any of the physical disk units which stores a designated logical volume to thereby access said designated logical volume,

said disk controller including:

a memory having a logical volume structure table storing a status of said plurality of physical disk units of each logical volume, and a disk management table storing statuses and the number of operations of each physical disk unit; and

a control unit which refers to said logical volume structure table with said designated logical volume, judges whether or not said status information of said logical volume indicates abnormal, and selects said single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal, and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal, and

wherein said status information stored in said table includes structure definition

information and mirroring information for each logical volume, and
wherein said mirroring information comprises a pair information indicating status
of said logical volumes in said table.

20. (CURRENTLY AMENDED) A RAID access method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, comprising:

referring to a memory storing a table indicating a plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volumes and status information indicating statuses and the operation numbers of said physical disk units;

judging whether or not said status information of logical volume indicates abnormal;

selecting a single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume; and

selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical volume when said status information of said logical volume indicates abnormal, and

wherein said status information stored in said table includes structure definition information and mirroring information for each logical volume, and

wherein said mirroring information comprises a pair information indicating status of said logical volumes in said table.